TECHNICAL REPORT
66-25-GP

DEVELOPMENT OF THE HEATER, IMMERSION, M-67, LIQUID-FUEL-FIRED, FOR CORRUGATED CANS

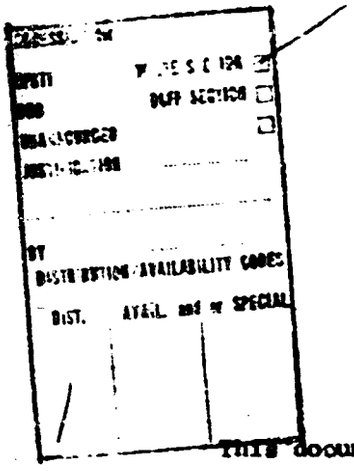
by

Cornelius J. McKeown

November 1967

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

General Equipment & Packaging Laboratory



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DEVELOPMENT OF THE HEATER, IMMERSION, M-67, LIQUID FUEL FIRED, FOR CORRUGATED CANS

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Cornelius J. McKeown
Support Equipment Division

AE Project 7054257

November 1967

General Equipment & Packaging Laboratory
U. S. ARMY NATICK LABORATORIES
Natick, Massachusetts

FOREWORD

A Value Engineering Task (06) was initiated to improve the Heater, Immersion, Liquid-Fuel-Fired, for Corrugated Cans (MIL-H-1597). The project was accomplished by the Support Equipment Division, General Equipment & Packaging Laboratory, U. S. Army Natick Laboratories, under the Application Engineering Technical Project No. 7054257. Mr. Cornelius J. McKeown served as Project Engineer.

This report covers the development of an improved heater from concept through the product improvement test.

Acknowledgement is accorded to Messrs. H. B. Levitz and J. M. Dunston, GEPL, for their encouragement and support of this project and to Mr. Armand Pellerin, Laboratory Support Office, for his comments and suggestions.

EDWARD A. NEBESKY, Ph.D.
Acting Director
General Equipment & Packaging Laboratory

APPROVED:

DALE H. SIELING, Ph.D.
Scientific Director

CLIFFORD T. RIORDAN
Colonel, QMC
Commanding

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ABSTRACT

This report describes the development of an improved Heater, Immersion, Liquid-Fuel-Fired, for Corrugated Cans, designated as M-67.

The new heater is expected to result in a 15% reduction in manufacturing cost; 50% reduction in erection time; reduction in the number of parts required to form a heater; and a heater more acceptable for field use. The specification for the immersion heater has been revised to the design of the M-67.

DEVELOPMENT OF THE HEATER, IMMERSION, M-67, LIQUID-FUEL-FIRED, FOR CORRUGATED CANS

Introduction

The purpose of this project was to design, fabricate and test an improved immersion heater for corrugated cans containing identical functions and capabilities as the current standard heater. The new heater was to incorporate current manufacturing capabilities, eliminate unnecessary parts and improve ease of assembly and operation. The new heater is designated as Heater, Immersion, M-67, Liquid-Fuel-Fired, for Corrugated Cans.

The immersion heater for corrugated cans is used to heat water for multipurpose field use such as field messing sanitation. In this application, mess kit laundries consist of a series of three corrugated cans holding approximately 80 quarts of boiling water per can. Each can is equipped with one immersion heater. The first can contains hot soapy water, the second and third cans contain boiling rinse water. In an emergency, the heater can be used for direct space heating of shelters or tents, and direct heating of liquid foods, such as coffee or soups.

This heater was adopted as standard in 1943 and has a procurement volume of approximately 6,000 units per year. The last procurement was for 9,354 units costing approximately $40.80 each.

Engineering studies by both the Defense Construction Supply Center and U. S. Army Natick Laboratories concluded that cost savings were feasible by redesign of the heater.

The standard heater (Figure 1) was procured from specification MIL-H-1597 (20 September 63) and identified by Federal Stock Number 4540-300-7952.

Standard Immersion Heater

The body of the standard heater is of water tight, sheet steel construction and consists of a torus-shaped combustion chamber and a stack assembly, all welded together. A vertical partition divides the stack into the two compartments - the burner compartment, and the flue compartment, through which the products of combustion leave the heater. A partition between the two stack compartments extends to the bottom of the heater and causes air entering the chamber from the burner compartment to circulate completely around the chamber before leaving by way of the flue compartment. Four sections of four inch smoke pipe are required to create the necessary draft.

Figure 1. Heater, Immersion, Standard Model

The fuel (gasoline) for the heater is supplied from a 2.2 gallon cylindrical tank held in place by a metal strap and knurled nuts. This tank is removed for filling and attached to the top of the heater during operation. Locking screws on the heater hanger hold the heater inside a standard 32 gallon can. The fuel valve, which is positioned over the burner compartment, meters the fuel to the burner. The burner, consisting of a vaporizer plate and sleeve, is placed in the bottom of the burner compartment. The fuel gravitates from metering valve to the burner where combustion takes place. The vaporizer plate consists of sheets of asbestos sandwiched between two sheets of perforated stainless steel.

Correct flow of the products of combustion must be established prior to lighting the heater. This is accomplished by swinging the lighter cup (Figure 2) beneath the metering valve so that the cup can be half filled with fuel. This fuel is then ignited and, while burning, placed in the flue compartment. This fire heats the air in the flue compartment in approximately 2 minutes causing a draft to be established. Once the correct flow is established, the burning cup is transferred to the burner compartment, the metering valve opened, and dripping fuel ignited by the cup flame. The cup is then placed into the flue compartment while the fire is automatically established at the burner. Once the fire is establisned at the burner, correct burning rate is attained by adjusting the valve. The cover is then closed. Closing the valve causes the heater to shut off.

M-67 Heater

The new M-67 heater functions and operates as does the standard heater. The major difference between the two is that the new heater utilizes standard, commercial, shelf items (where possible) and eliminates superfluous parts. The shape of the heater combustion chamber facilitates construction by either spinning or drawing. Spinning the two components of the base does not require expensive manufacturing tools and dies. The prototypes used for testing and shown in Figure 3 were spun without difficulty.

TABLE 1

COMPARISON OF STANDARD AND M-67 IMMERSION HEATER

	M-67	STANDARD
Capacities		
Fuel Tank Gal	2.2	2.2
Heat Output (acceptable smoke) BTU	35,000	35,000
Heat Output (Max) BTU	132,000	132,000

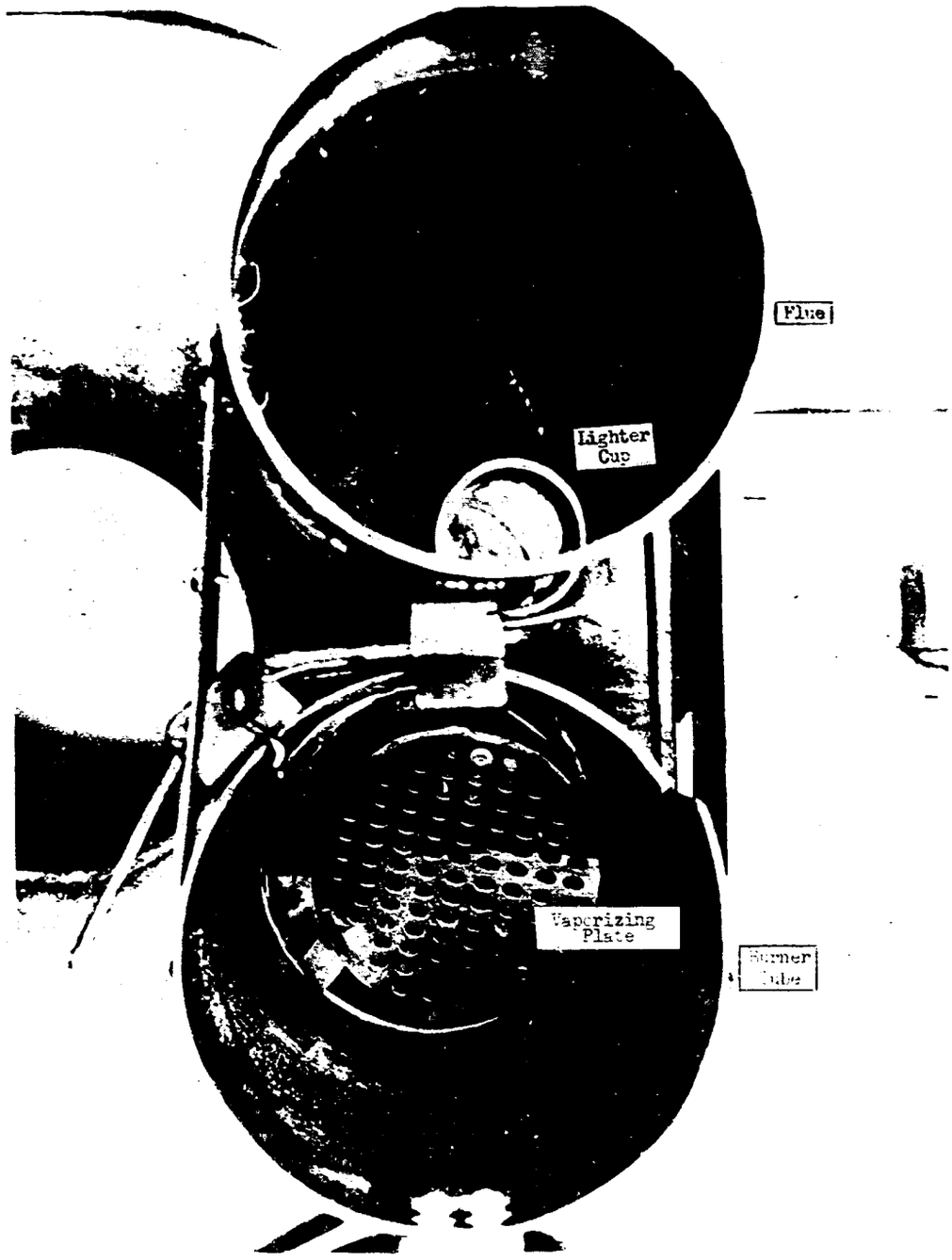

Figure 2. Lighter Cup and Vaporizing Plate of M-67 Heater.

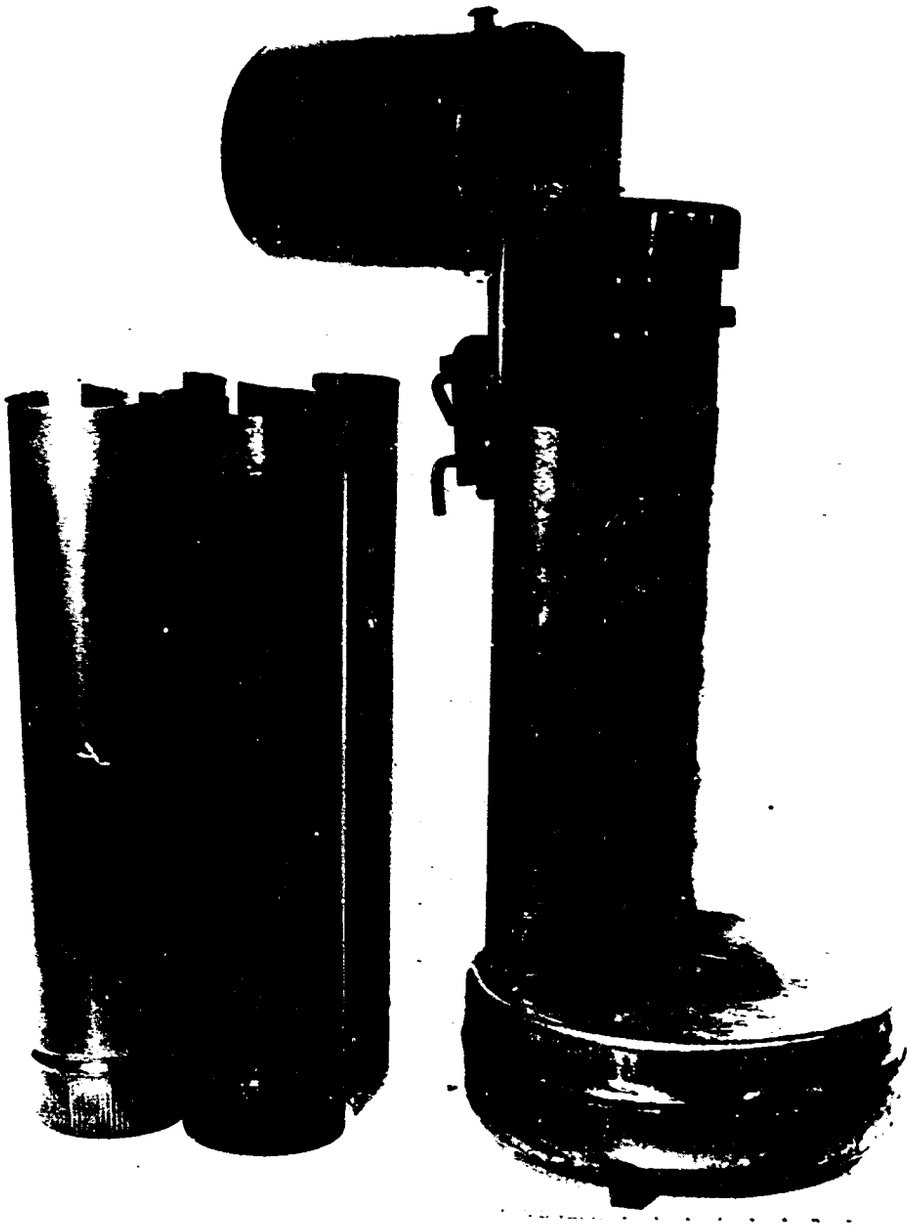

Figure 3. New M-67 Heater

TABLE 1 (cont'd)

	M-67	STANDARD
Diameter (inches)		
Combustion Chamber	15	15
Stove Pipe	4	4
Burner Tube	4-1/2	4-1/2 x 4-1/8
Flue Tube	4	4-1/2 x 4-1/8
Fuel Tank	8	8
Length (inches)		
Burner	9	12-3/8
Heater only	34-3/4	30
Heater w/fuel Tank	36	33-3/4
Heater completion	121	118-5/8
Weight (lb. - oz.)		
Main Body	27-6	29-6
Tank	5-0	3-6
Burner	0-15	0-10
Smoke Pipe (4)	1-8	1-8
Complete	34-13	34-14

Comparison of Heaters:

Flue and Burner Tube. The new heater utilizes commercial standard seamless or welded steel tubes in lieu of the elliptical partition-type used on the old heater. The old heater required two welds along the length of the tube, plus complete fabrication (Figure 4). Additional heat transfer surfaces are added by the use of tubes.

Lighter. Only the dimensions of this item were changed. The wicking and retainer spring are identical with the standard.

Igniter Guard. This item was added to the new heater. This is a 5-1/2", 16-gage steel plate which protects the lighter flame from the direct wind, and is also used to attach the identification plate.

Stove Pipe. There is no change in the requirement of four 4"-diameter stove pipes.

Backing Plate. A new backing plate is constructed from two rectangular pieces of steel welded together (Figure 5). This eliminates the waste of metal resulting from stamping of the old type, and eliminates the 3/16-inch cotter pin.

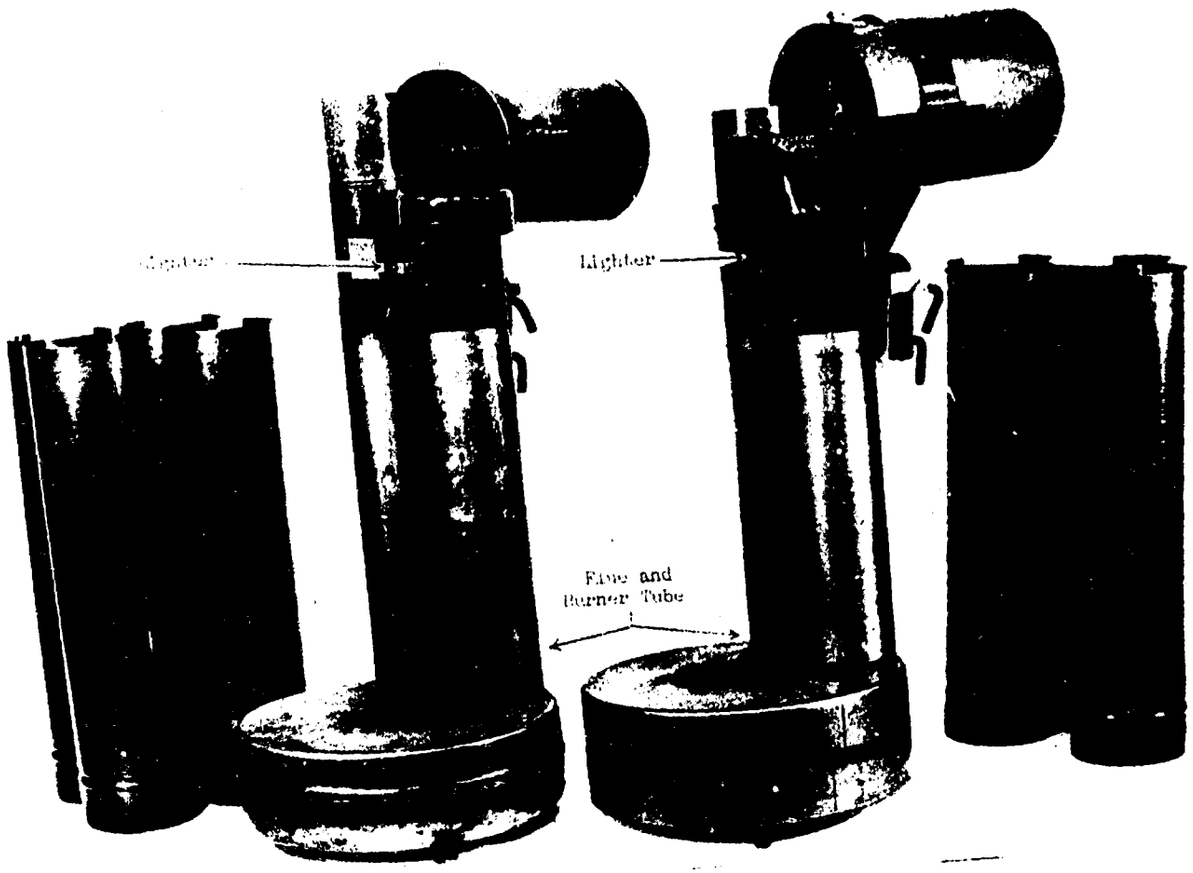

Figure 4. Comparison of Seam (or Weld) Requirements of the Two Heaters

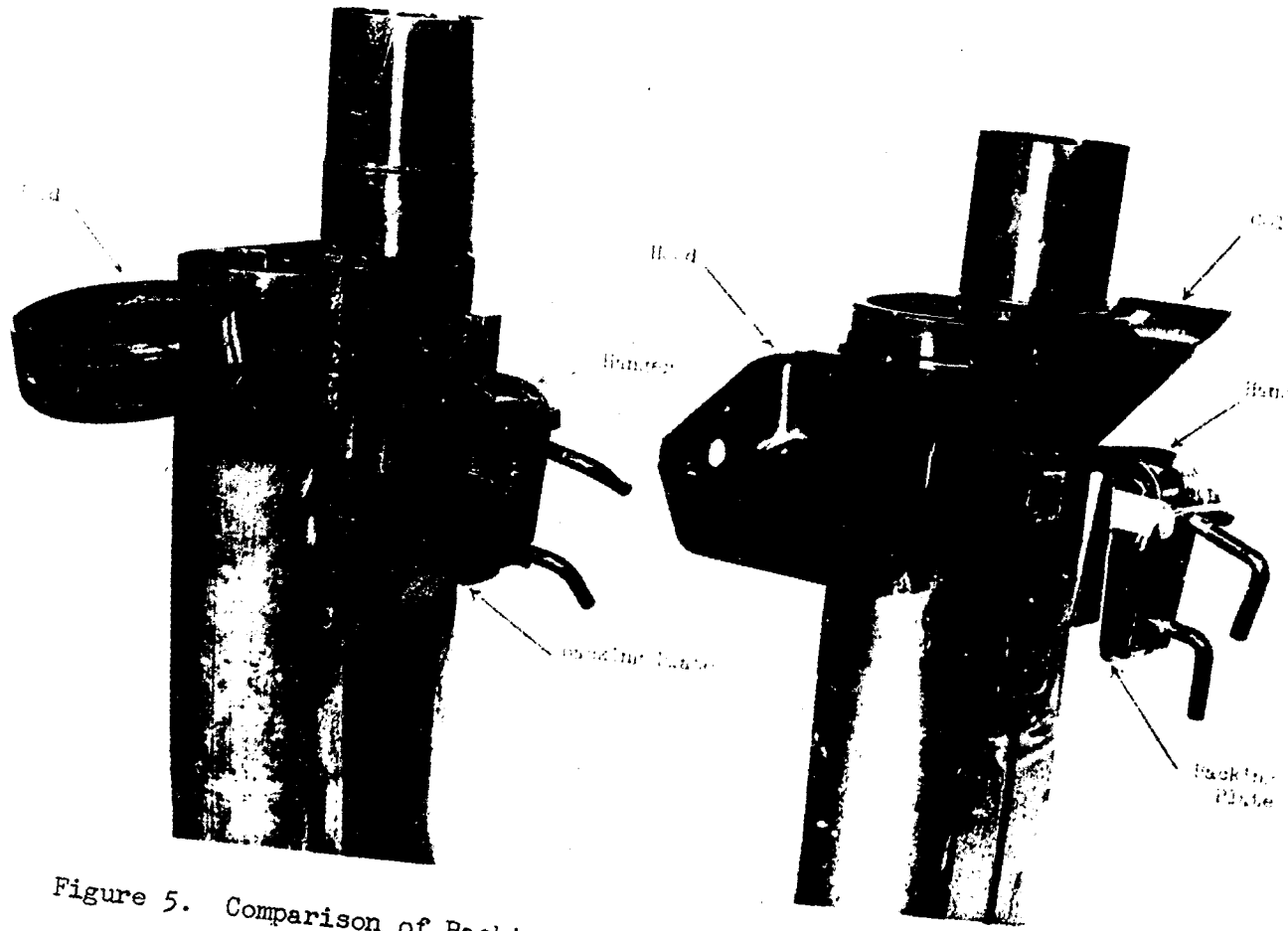

Figure 5. Comparison of Backing Plates on M-67 and Standard Heaters

Hanger. The new heater uses a 1-1/2" steel channel bent to shape. The extensive welding of the hanger brace to the channel has been eliminated. Also, the expensive fabrication operation of shearing the channel has been eliminated.

Hood. The odd shape used on the standard heater, which resulted in an expensive and difficult drawing operation, has been replaced with a cylindrical cover. The new heater uses a commercial, inexpensive hinge rather than specially fabricated hinge brackets and cotter pins. The cover is bolted to the heater, allowing replacement of this item.

Collar. This item, requiring 12 parts, has been eliminated in the design of the new heater.

Heater Body. The new heater has four major sections: The bottom pan, top pan, center tube and baffle. The shape of both pans allow manufacturing by spinning. The center tube in the heater is a standard commercial size tube unlike the standard heater tube which requires fabrication. The bottom pan on the new heater was given a slight bevel which eliminated steam pressure formation and vibration which occurred in the standard heater (Figure 6).

One of the major deficiencies of the standard heater was the difficulty in welding all four edges of the baffle. The lack of continuous weld of the baffle permitted openings which, through use, become warped and allow the flue gases to by-pass the base. This deficiency greatly reduced the heat transfer area and the output of the heater.

The new heater, by its construction, easily allows the welding of all four sides prior to the attachment of tubes. The decrease in welding required to fabricate the base also reduces the fabrication cost and field problems in cleaning the heater.

Partition. The standard heater flue tube is of divided construction with a partition running the length of the tube. This partition is necessary to separate the downward flow of air and fuel and the upward flow of products of combustion. Because of this construction it is difficult to weld the bottom edge of this partition to the top of the base (Figure 7). Any opening in this partition causes a by-pass of the flue resulting in warpage which greatly reduces the output of the heater.

This difficulty has been corrected in the new heater. In testing, the experimental heater operated without any failure of baffles, whereas the baffles of the standard heater warped after approximately 84 hours of operation.

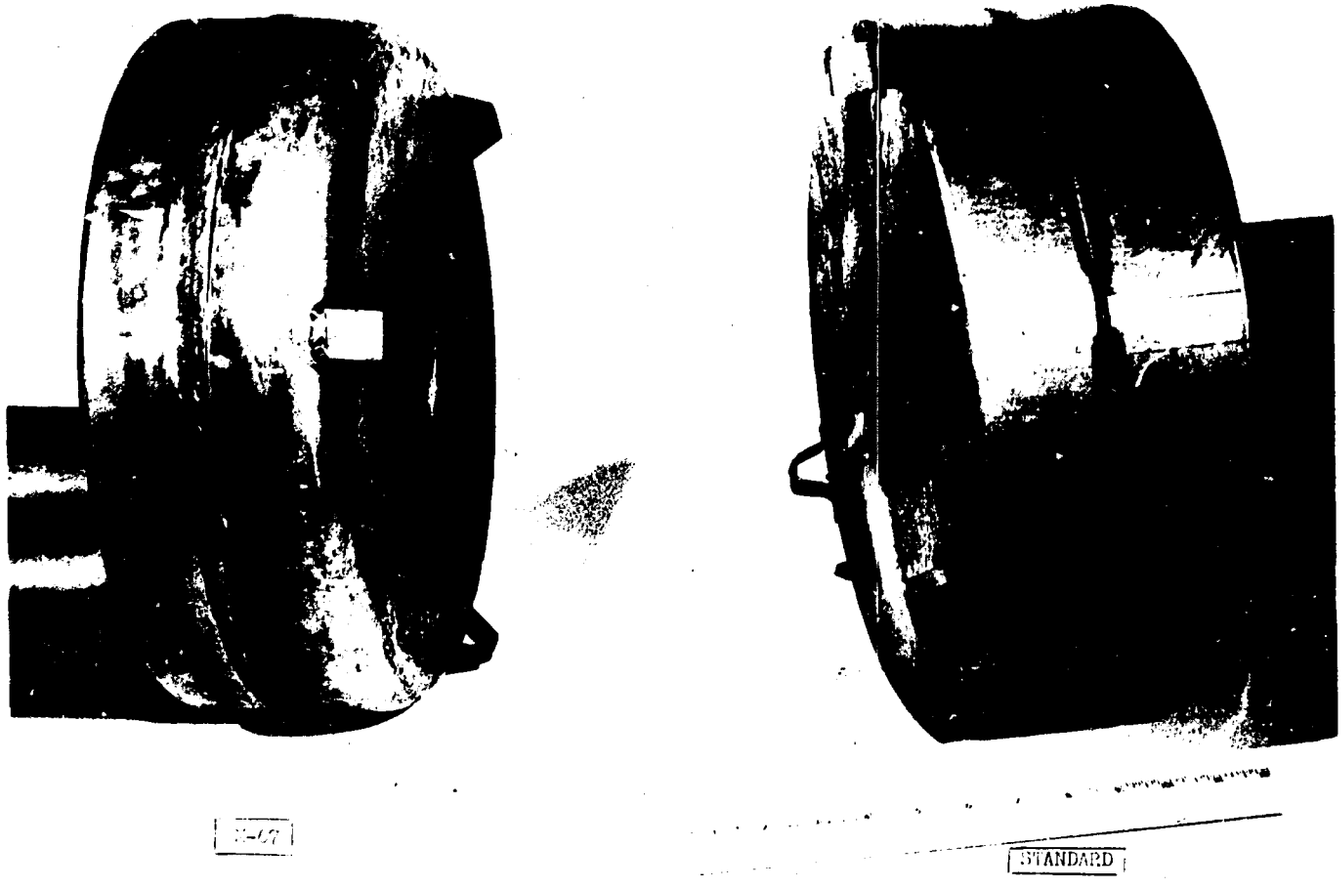

Figure 6. New Heater Containing Slightly Beveled Bottom Pan

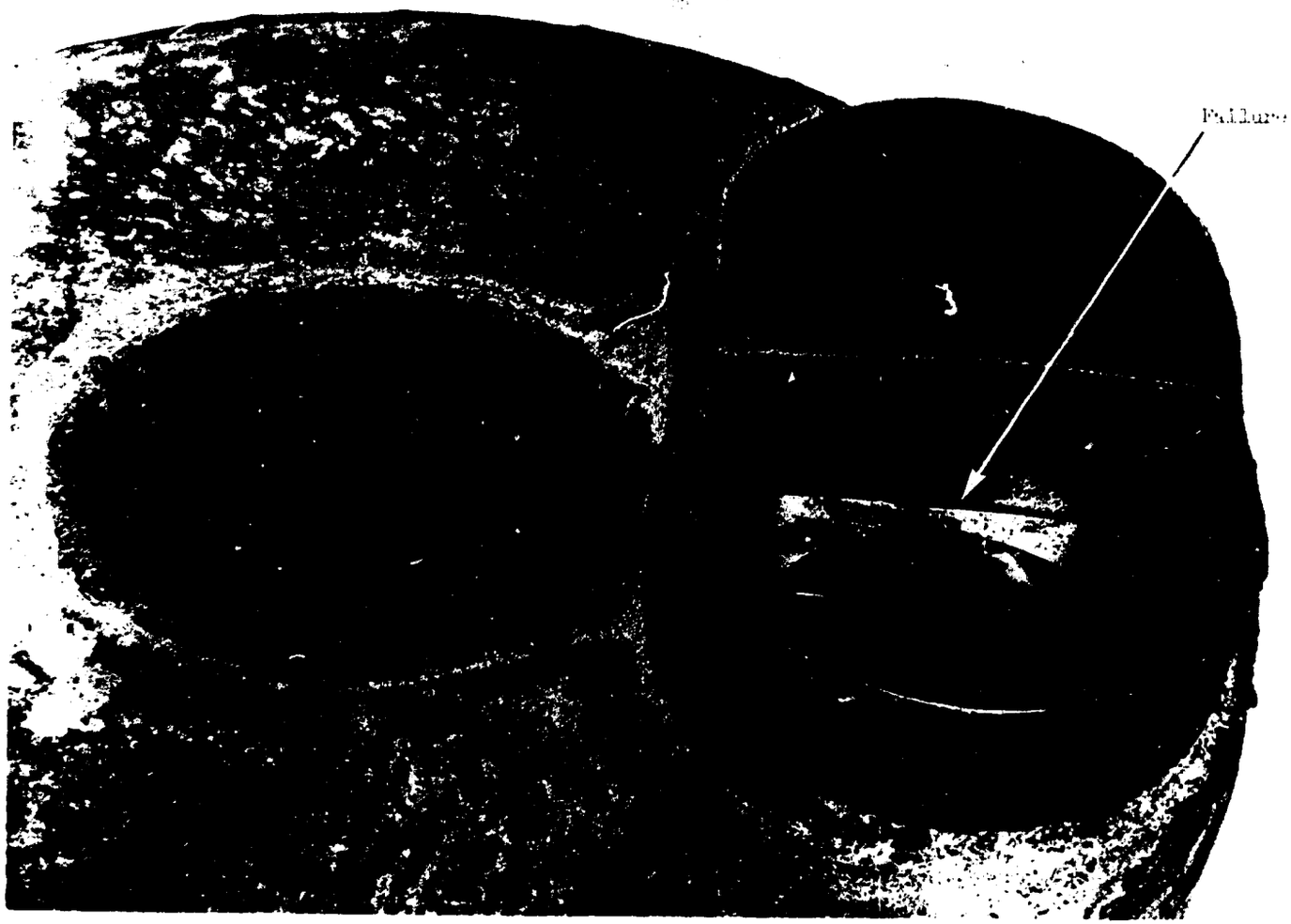

Figure 7. Standard Heater Showing Failure at Partition

Burner. The new burner is designed with a cast iron vaporizing plate attached by rivets to four 1/2" stainless steel legs which are welded to a 4 inch diameter ring (Figure 8). The complete burner is largely composed of standard commercial items requiring no special dies or tools except for the casting of the burner plate. The new design eliminates four components.

Fuel tank. The tank strap, consisting of 18 components, has been replaced by a square tube and plate welded to the tank (Figure 9). This change not only reduces the fabrication cost, but eliminates the bothersome procedure of removal of the tank attachments when refueling is necessary. No change was made to the tank plug or elbow.

Valve. The valve handle has been changed to a hexagon head rather than the round knurled type. This change eliminates the knurling machinery operation and allows the manufacturer to use a commercial standard hexagon rod for fabrication.

Product Testing

Twenty prototypes of the M-67 immersion heater were submitted to USATECOM for Product Improvement Test. Tables 2 and 3 contain results of the complete run and metered fuel tests. These tests concluded that the heaters, as modified during the test, meet the functional requirements of the standard immersion heater. The test also concluded that (1) the experimental heater compared satisfactorily in weight, size, performance and efficiency with the standard immersion heater; (2) the new heater had no failure in the baffles; (3) the modified tanks functioned satisfactorily without failures; and (4) the new heater could be assembled and disassembled more easily than the standard heater.[1]

TABLE 2

COMPLETE RUN

Type Heater	No. Trials	Averages					
		Amb. Temp.(°F)	Initial Water Temp.(°F)	Boil Time (Min)	Total Operation Time(Min)	Total Fuel Used(Oz)	Fuel Rate (Oz/Min)
Experimental	125	48	55	58	243	142	.6
Standard	92	44	52	58	318	181	.6

[1]Heater, Immersion, Final Report of Project 7-7-0877-01, USATECOM, April 1967.

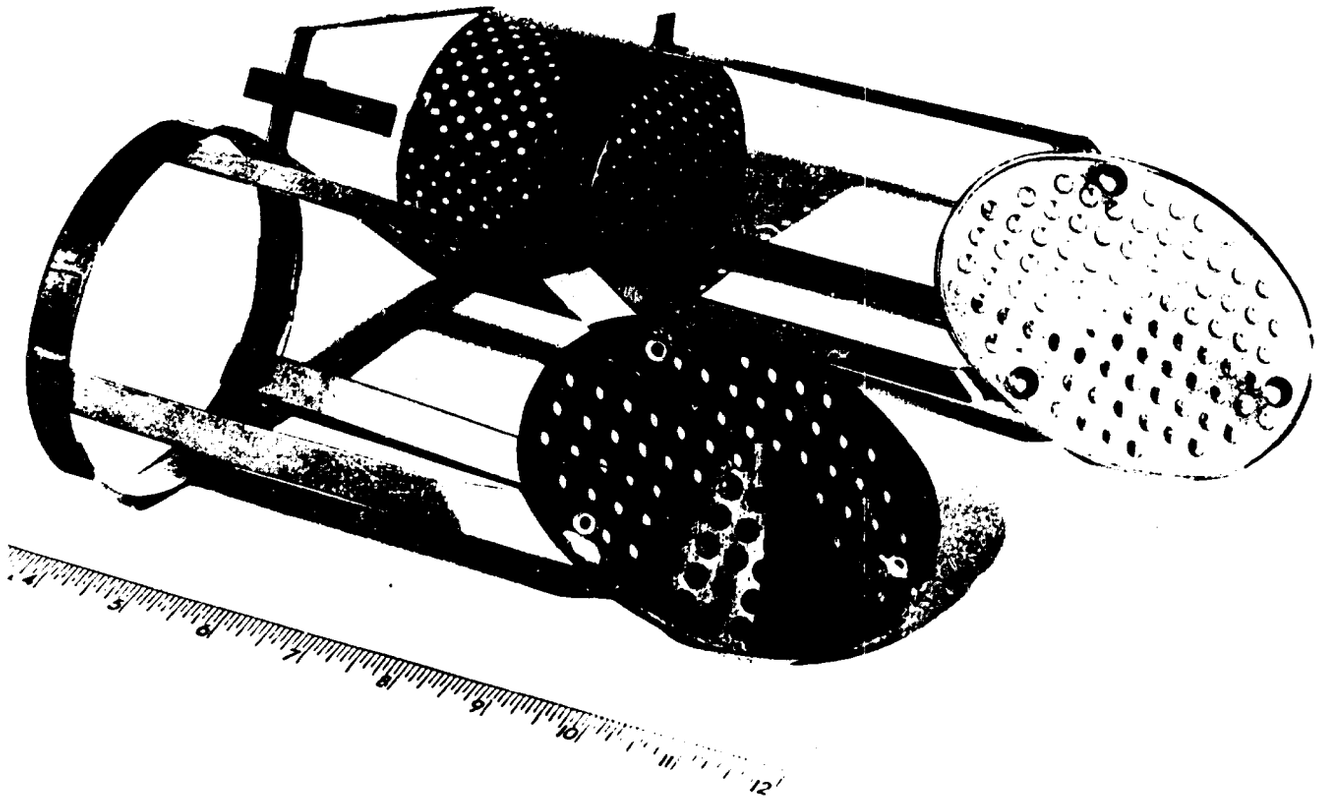

Figure 8. Vaporizing Plate

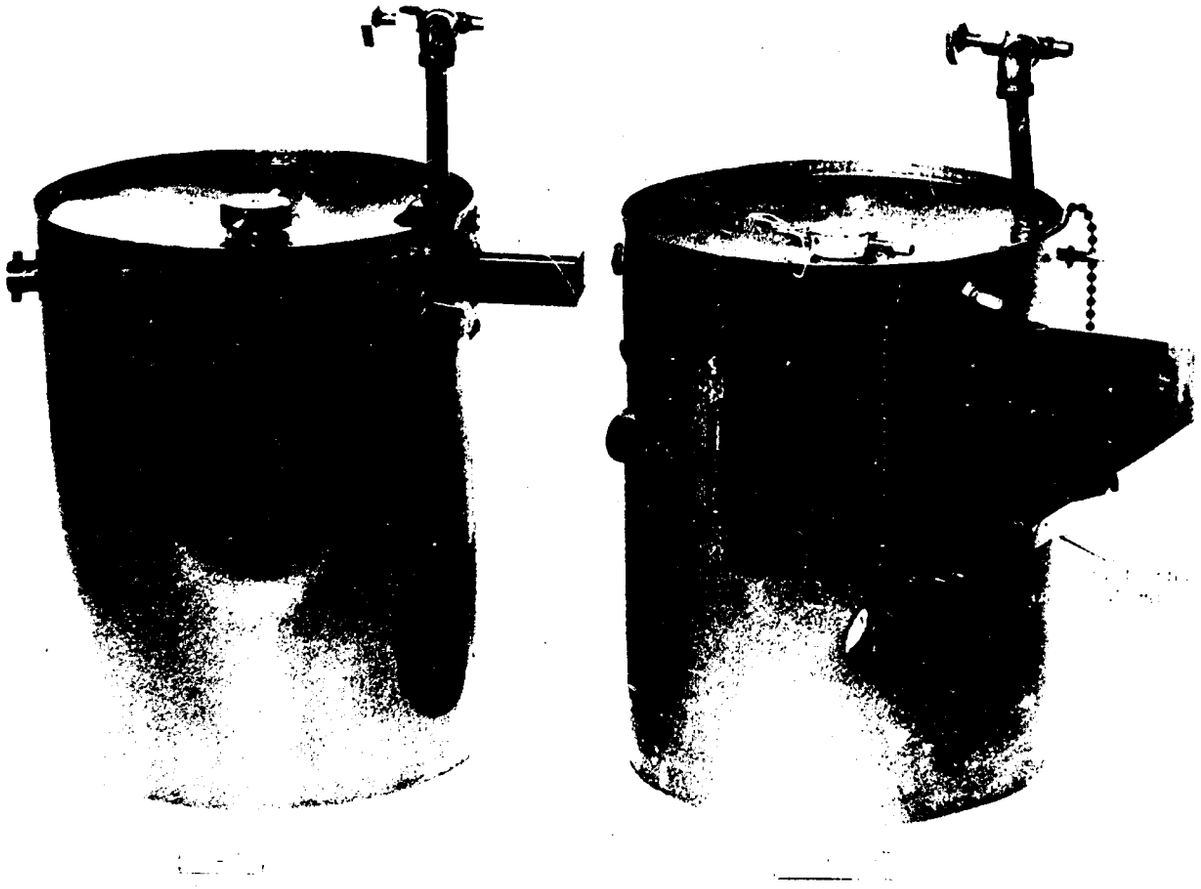

Figure 9. Fuel Tank Strap

TABLE 3

METERED FUEL TESTS

Type Heater	No. Trials	Averages							
		Meter Setting	Amb. Temp(°F)	Initial Water Temp(°F)	Boil Time (Min)	Fuel Flow (Oz/Min)	Total Fuel (Ozs)	Stack Temp (°F)	Stack Gas CO_2 (%)
Experimental	5	6	62	63	67	1.0	67	-	-
Standard	5	6	62	63	70	.9	63	-	-
Experimental	5	7	61	66	54	1.2	65	755	8
Standard	5	7	61	66	58	1.2	70	777	8
Experimental	3	8	43	48	45	1.5	68	843	13
Standard	3	8	43	48	45	1.7	77	827	10
Experimental	4	9	46	61	58	1.8	104	765	12
Standard	4	9	46	61	59	1.8	106	763	11

The comparison test concluded that both heaters are comparative in efficiency, output and range. It should be noted that both have an efficiency of 60% at an input of approximately 33,000 BTUH.

Conclusion

Changes to MIL-H-43540 incorporating the modifications for the M-67 model were approved on 15 September 1967.

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7. Military Specification MIL-H-43540, Heater, Immersion, 15 September 67.

8. Technical Manual 10-4540-201-15, Heater, Immersion, January 1961.

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